Evaluation of 18/0 Circle Hook in the Gulf of Mexico Tuna Fishery

Report on Experiments Conducted in 2004

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Executive Summary

Studies conducted in the Western Atlantic Ocean Northeast Distant Waters (NED) have demonstrated that 18/0 circle hooks can significantly reduce sea turtle interactions in the pelagic longline fishery compared to industry standard 9/0 "J" hooks without significantly impacting target species catch rates for swordfish and bigeye tuna. The impact of 18/0 circle hooks on other pelagic longline target species is not known. NOAA Fisheries Southeast Fisheries Science Center conducted experiments in the Gulf of Mexico from February through April, 2004 to evaluate the effect of 18/0 circle hooks in the directed fishery for yellowfin tuna. 18/0 0° offset circle hooks were evaluated against 16/0 0° offset circle hooks using sardines as bait. Three cooperative commercial pelagic longline vessels made 61 research sets during 7 trips fishing a total of 29,570 hooks. Three leatherback turtles were caught during the experiments, 2 on 18/0 circle hooks and 1 on 16/0 circle hooks. The turtles were all foul hooked and were released alive. No loggerhead turtles were caught during the experiments. There was a 25.7% reduction in total yellowfin tuna caught on 18/0 circle hooks compared to 16/0 circle hooks which was statistically significant ($p = 0.0025$). There was a 25.7% reduction by weight for marketable yellowfin tuna caught on 18/0 circle hooks compared to 16/0 circle hooks which was also statistically significant ($p = 0.0183$). These data indicate that 18/0 circle hooks fished with sardine bait are less efficient for yellowfin tuna than 16/0 circle hooks with sardine bait.

Introduction

The incidental capture of threatened and endangered sea turtles by pelagic longline gear used in the harvest of swordfish, and tuna worldwide has become a serious concern for fisheries managers (Lewison et al., 2004). Research conducted by NOAA Fisheries in the Western Atlantic Ocean Northeast Distant Waters (NED) pelagic longline fishery has demonstrated the effectiveness of 18/0 circle hooks with minimum offset (0-10°) in reducing sea turtle interactions (Watson et al., 2004). When used with mackerel bait 18/0 circle hooks maintained swordfish catch rates compared to the industry standard 9/0 "J" hooks with squid bait. Also, 18/0 circle hooks maintained bigeye tuna catch rates when used with squid bait. Circle hooks also significantly reduced the rate of hook ingestion by loggerhead sea turtles, potentially reducing post hooking mortality. Other studies have indicated the probability of survival after the interaction with circle hooks is higher than with traditional "J" hooks because circle hooks usually hook animals in their jaw and the hooks are not swallowed (Lucy and Studholme 2002). Whether circle hooks also effectively reduce the number of interactions with loggerhead turtles appears to be a function of the size of the circle hook and the size of the animal (Watson et al. 2003) and may also be a function of bait type. Bolten et al. (2002) found no difference in the loggerhead sea turtle interaction rate between 16/0 non offset circle hooks and 9/0 non offset "J" hooks with squid bait, but did find a significant difference (Chi-square test, $p < 0.001$) in the hooking location between the "J" hooks and circle hooks. In contrast to the Azores study; a summary of the U.S. pelagic longline observer data from the Gulf of Mexico, 1992-2002, indicates "J" hooks had a higher average catch rate of marine turtles than 15/0 and 16/0 circle hooks (Garrison, 2003); in fact no loggerhead turtles have been

observed captured on circle hooks in the Gulf of Mexico. The difference in these data may be that the majority of "J" hooks used in the Gulf of Mexico are smaller than 9/0 and the bait used in the Gulf of Mexico is primarily small fish (sardines and herring) versus squid bait used in the Azores study. Leatherback sea turtle interactions with pelagic longline gear; unlike loggerhead interactions are primarily foul hooking and both 16/0 and 18/0 circle hooks have been found to significantly reduce leatherback interactions (Garrison 2003, Javitech 2002). The effect of 18/0 circle hooks on yellowfin tuna the primary target species in the Gulf of Mexico is not known. Preliminary data from the NED study indicated no significant difference in the catch rates for yellowfin tuna for the 16/0 and 18/0 circle hooks for either numbers or weight of fish ($p = 0.8197$ and $p = 0.9109$ respectively) (Watson et al., 2004). NOAA Fisheries conducted research in the Gulf of Mexico from February through April, 2004 to compare 0° offset 18/0 circle hooks with 0° offset 16/0 circle hooks on the catch rates of yellowfin tuna. This report presents the results of the Gulf of Mexico research.

Experimental Design

Research was conducted in the Gulf of Mexico (GOM) statistical reporting area (Fig. 1) between February and April 2004. The objectives of the research were to determine the efficiency of 0° offset 18/0 circle hooks on yellowfin tuna catch rates and to collect data on the effect of 0° offset 18/0 circle hooks on bycatch species when compared to 0° offset 16/0 circle hooks. Research was conducted on cooperative commercial pelagic longline vessels who volunteered to conduct fishing operations in adherence with the research experimental design. The control treatment hook design was the Mustad[1] 39960 0° offset 16/0 circle hook and the experimental treatment hook design was the Mustad 39960 0° offset 18/0 circle hook. The experimental design was to alternate 16/0 circle hooks and 18/0 circle hooks baited with sardine bait along the entire set (paired design) with an odd number of hooks between floats and an equal distance between hooks and between hooks and adjacent floats (randomized hook pattern) (Fig. 2). All participating vessels were required to standardize fishing gear in order to reduce variability associated with gear configuration (Table 1). All vessels participating in the experiment carried observers and both observers and vessel captains were provided training on the requirements of the experimental design. Observers collected fishery data as described for the Southeast Fisheries Science Center (SEFSC) Pelagic Longline Observer program (Beerkircher et al. 2002). Observers provided at sea oversight to ensure that fishing operations were conducted according to the experimental design.

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Results

Three commercial pelagic longline vessels participated in the research making 61 sets in 7 trips fishing a total of 29,570 hooks. Three leatherback turtles were caught during the experiment; 2 on 18/0 circle hooks (cpue = 0.135 per 1,000 hooks) and 1 leatherback on 16/0 circle hooks (cpue = 0.068 per 1,000 hooks) (Table 2). The sample size was too small to detect any significant difference between the hook types for leatherback turtles. The observed cpues for leatherback turtles were much lower than reported by Garrison, 2003 from observer data in the GOM in 2002 (cpue 0.237 per 1,000 hooks), and by Watson et al, 2003 for "J" hooks in the NED (cpue = .352 per 1,000 hooks,) which we would expect with the use of circle hooks versus "J" hooks. All three leatherback turtles were fouled hooked and were released alive. Although the hooks were not removed, the line remaining on the turtles at release was less than ½ the carapace length in each case. No loggerhead turtles were caught.

Three hundred and forty seven yellowfin tuna were caught on 16/0 circle hooks (cpue = 0.0235) and 250 yellowfin tuna were caught on 18/0 circle hooks (cpue = 0.0169) (Table 2). There was a 26.5% reduction in total yellowfin tuna caught on the 18/0 circle hook compared to the 16/0 circle hook which was statistically significant ($p = 0.0025$). The cpue for marketable yellowfin tuna by weight caught on the 18/0 circle hook was 1.07 lbs/hook and 1.44 lbs/hook for the 16/0 circle hook. There was a 25.7% reduction by weight for marketable yellowfin tuna caught on 18/0 circle hooks compared to 16/0 circle hooks which was statistically significant ($p = 0.0183$). The above p values were computed using paired t-test on catch per unit hook for each set. These p-values are in

agreement with those from fitting a model with total catch as the dependant variable and number of hooks and treatment as independent variables. These results indicate that the use of 18/0 circle hooks in the directed tuna fishery could result in economic loss to the fishery when compared to the 16/0 circle hook.

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Table1. Pelagic longline gear experimental design standardization requirements.

Gear Standardization Requirements
• Branch lines were at least 110% of the float line length if total length of branch line and float line was less than 100 meters. • Hook spacing was the same within a set. • Branch line length was uniform within a set. • Float line length was uniform within a set. • Fished odd number of hooks (3 or more) between floats. • Bait was sardines • Baiting technique was the same within a set. • Control hooks were 16/0 non offset circle hooks. • Treatments hooks were 18/0 non offset circle hooks • No light sticks were used. • All leaders or snaps were color coded in a manner that allowed positive identification of hook type used.

Table 2. Catch rates for 0° offset 16/0 circle hooks and 0° offset 18/0 circle hooks baited with sardine bait.

Species	**16/0 Circle Hook** (n = 14,785)	**18/0 Circle Hook** (n = 14,785)
Loggerhead Turtle	0	0
Leatherback Turtle	1 (cpue = 0.000068)	2 (cpue = 0.00013)
Yellowfin Tuna (Count)	347 (cpue = 0.0235)	250 (cpue = 0.0169)
Yellowfin Tuna (weight of marketable fish)	1.44 lbs/hook	1.07 lbs/hook

Figure 1. Pelagic longline fishing areas. Source: Cramer and Adams, 2000.

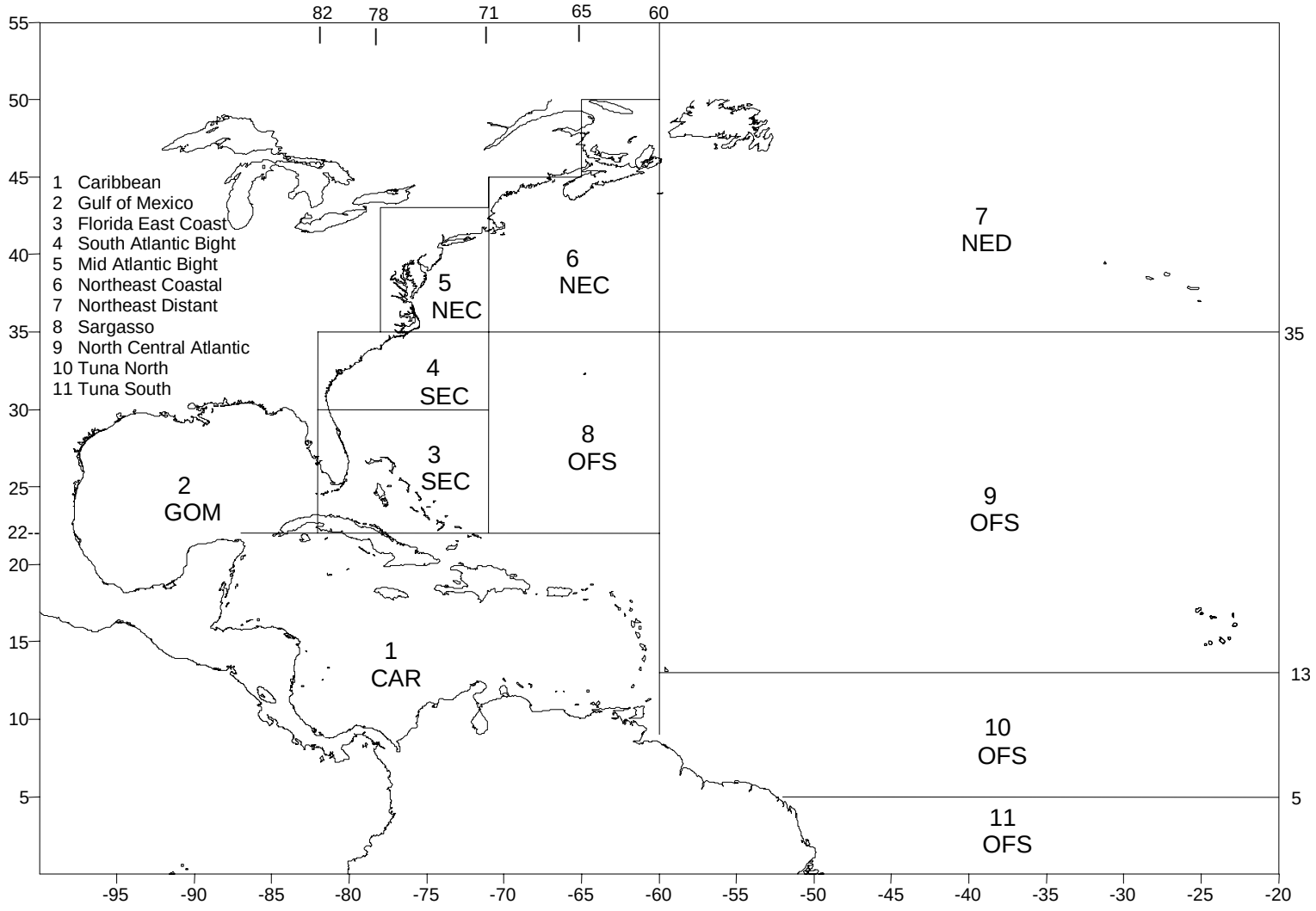

Figure 2. Expermental design gear configuration.